Search for fermiophobic Higgs boson in multi-photon final states at DZero

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Fermiophobia

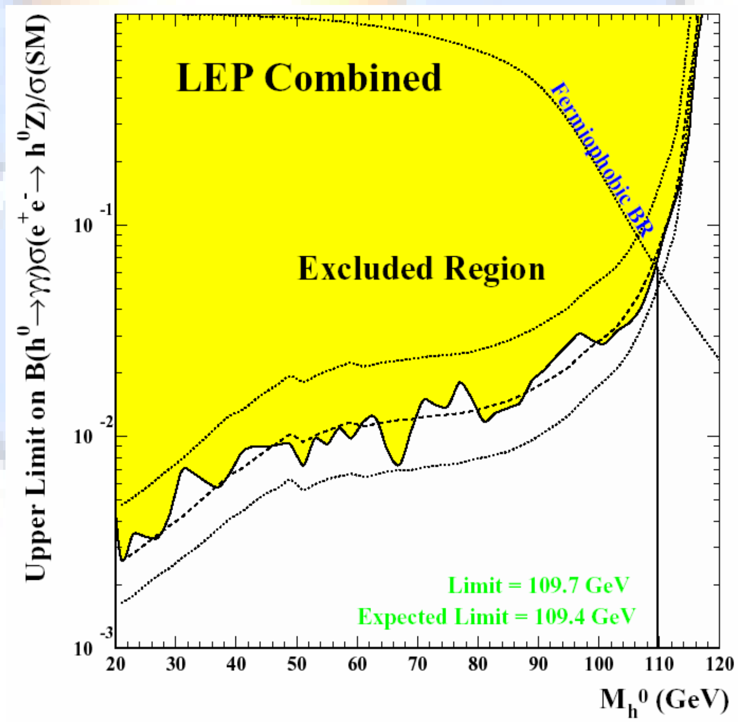
- Higgs decaying to bosons has been searched at LEP and Tevatron

$\longrightarrow$ LEPII $\approx$ 108 GeV; Run I $\approx$ 80 GeV

- previously derived limits are done with the assumption of the SM *hVV* couplings:

$$R = \frac{\sigma\left(e^+e^- \to Zh_f\right)}{\sigma\left(e^+e^- \to Z\phi^0\right)} = 1$$

- this is not entirely true in more realistic models, i.e. 2HDM, THDM;
- it is possible that lighter Higgs masses have eluded previous searches
- moreover, lighter masses are more theoretically favorable



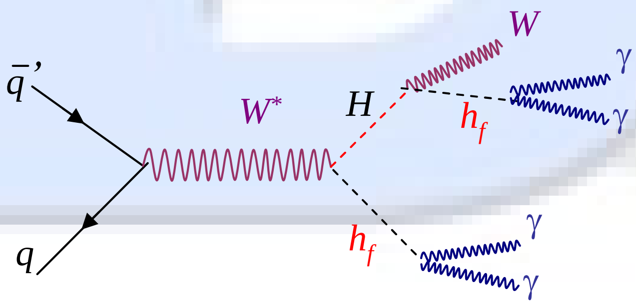
Fermiophobia in 2HDM

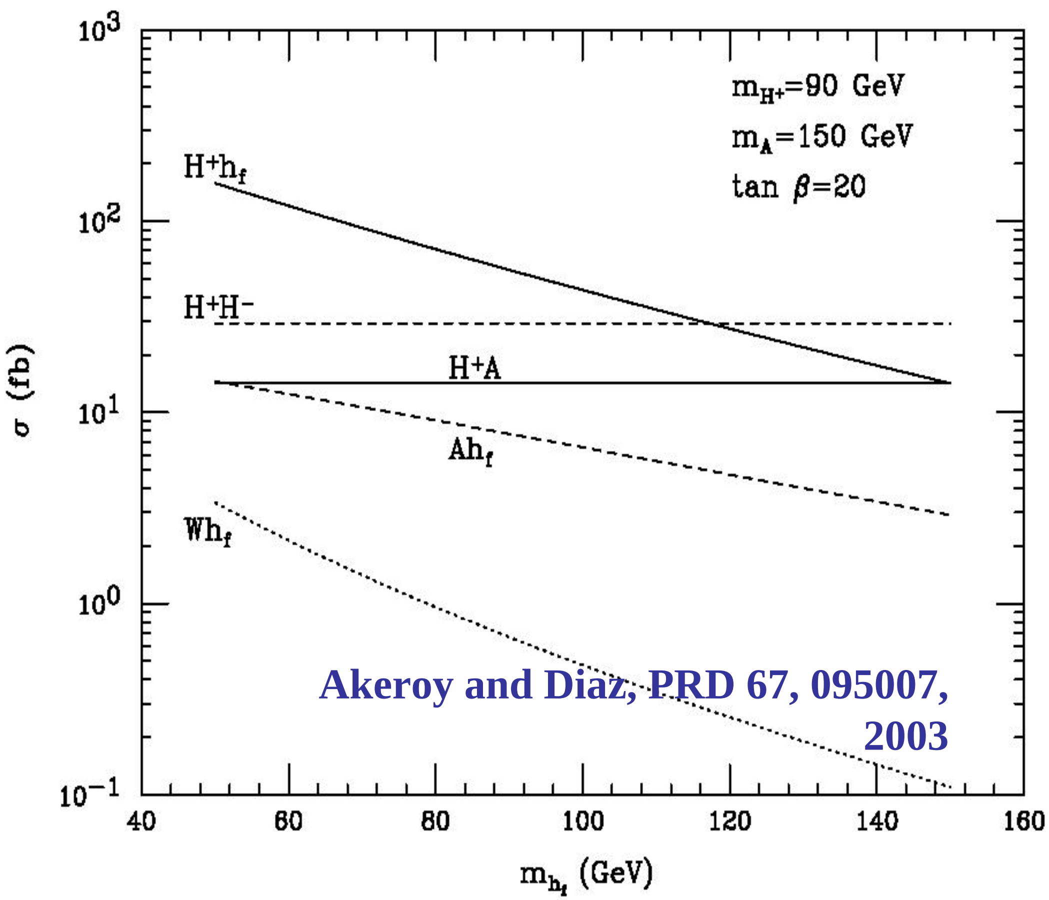
For $\tan\beta = 3$ lighter masses might have gone undetected $m_{h_f} = 80\,GeV/c^2$

due to: $h_f VV \sim 1/(1+\tan^2\beta)$

This suppression opens new channels:

$$p\bar{p} \rightarrow H^{\pm}h_f,\; H^{\pm}H^{\mp}, \text{and } A^0 h_f$$





Akeroy and Diaz, PRD 67, 095007, 2003

Tools – Tevatron, DZero

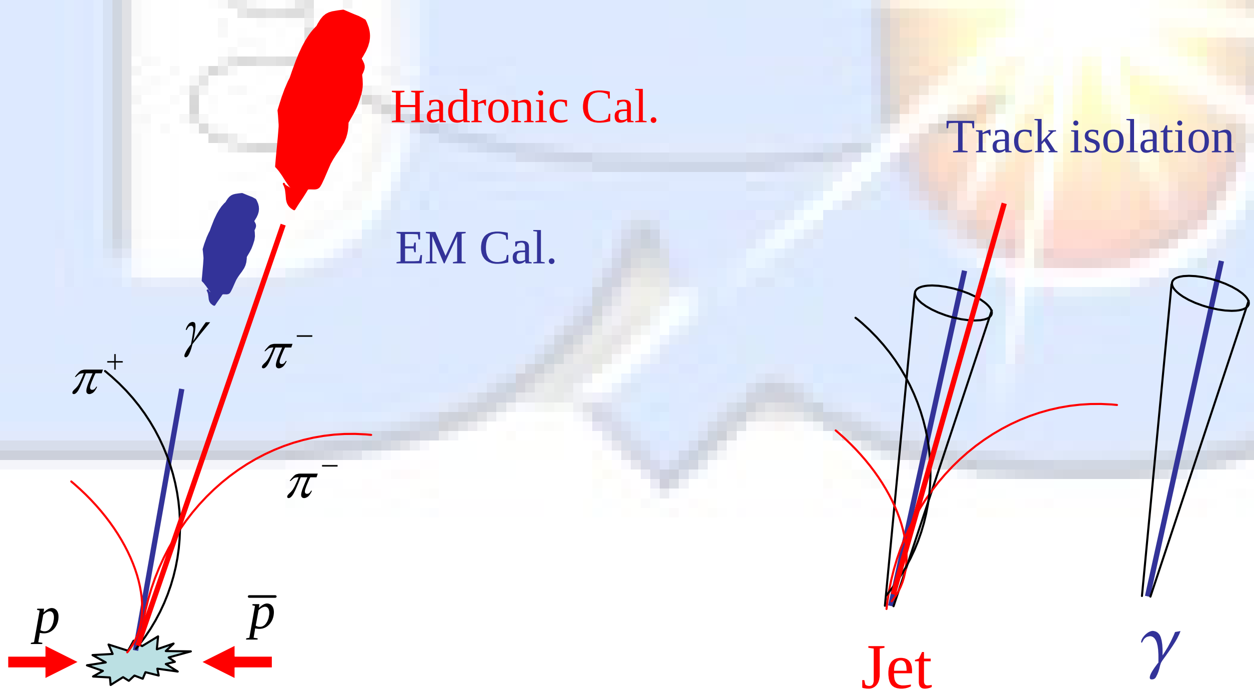
- Highest energy machine – extended kinematic reach into the phase-spaces of various models;
- excellent EM Calorimeter, significant rapidity coverage;
- very good tracking system;
- a crew of hard working colleagues working on perfecting the quality of data;

Photon Identification

- difficult to calibrate;
- lots of QCD background – jets with energetic photons (from π^0's and η's):
- similar to electron signature in the calorimeter;

$\rightarrow$ luckily a significant track activity from the fragmentation and FSR around a photon candidate.

$\rightarrow$ larger conversion probability for "fake" photons.



Analysis

- Backgrounds for 1γ and 2γ event topologies are very large.

  Use 3γ & 4γ, acceptance $\approx 50\%$

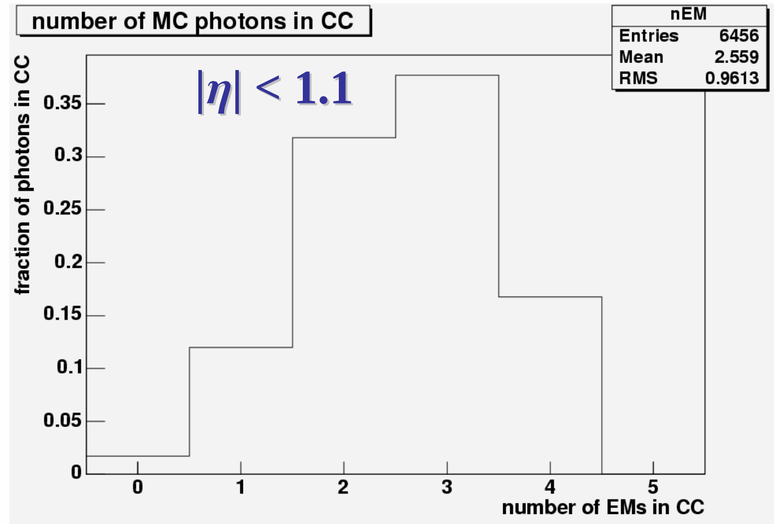
- photons are very energetic which allows very tight cuts

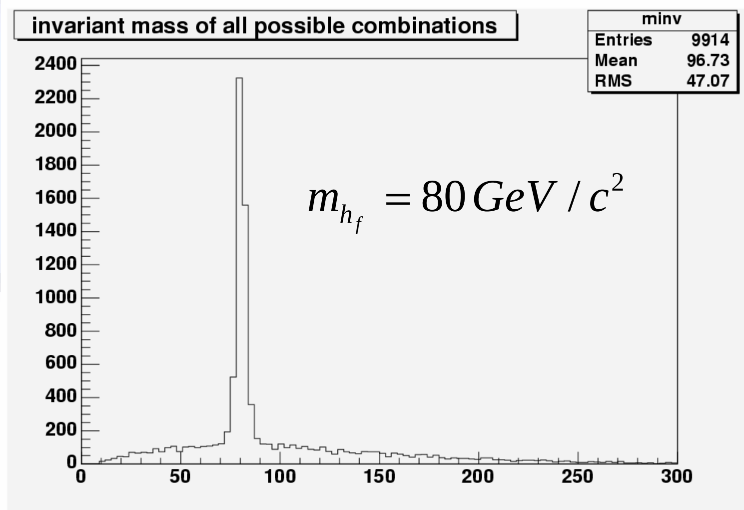
  $m_{h_f} = 80\,GeV$:

  $p^{\gamma}_{\perp,1} > 45\,GeV,\ p^{\gamma}_{\perp,2} > 25\,GeV,$

  and $p^{\gamma}_{\perp,3} > 15\,GeV$

- distribution of invariant masses of all possible combinations for 3γ and 4γ has only a small effect of the "wrong pair" background and adds only $\gtrsim$10% to the width of the mass peak;





Analysis

- EW backgrounds:

  W($e\nu$)+2jets, Z(ee)+jet, and Z+γ
- QCD backgrounds:

  3jets
- direct photons (should be out of the fake rate):

  γ+jet, 2γ+jets

Very Preliminary Results

Background	Theory	Suppression	Expected
✓ $W(e\nu)$ + 2 jets	(2,963±2.29)pb	$O(1.9\cdot10^{-7})$	O(0.20)
✓ Z(ee) + jet	(67.8±0.24)pb	$O(1.8\cdot10^{-4})$	O(0.25)
✓ Z(ee) + γ	(0.13±0.0012)pb	$O(1.6\cdot10^{-3})$	O(0.10)
✓ 3 jets, 2 jets, 2γ + jet (from 2γ + jet sample)			O(2.3)
Total expected background :			**2.9**
Observed:			**4**

Conclusions

- A new analysis – was not tried at LEP and the Tevatron;
- a good control of the major backgrounds;
- allows to expand the phase space coverage to larger tan β, where the conventional mechanisms are suppressed;
- can probe low masses (down to ~50 GeV/c^2), which is generally a challenge at the hadron colliders;
- may invert a problem and put tighter constraints on (*fermiophobic*) higgs-strahlung in 2HDM/THDM (no W/Z BRs suppressions)… (crazy/bold?);

- accelerator is performing really well – record inst. luminosities every moth;
- experiment is delivering ever-perfecting quality data – already have ~0.6fb^{-1};
- tight limit (or discovery?) is coming stay tuned…